GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Atomic and molecular physics, PG_00037283		
Field of study	Technical Physics		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2023/2024
Education level	first-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	3	Language of instruction	Polish
Semester of study	6	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Atomic, Molecular and Optical Physics -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Radosław Szmytkowski	
	Teachers	dr Mykola Shopa prof. dr hab. Radosław Szmytkowski	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	15.0	0.0	0.0	75
	E-learning hours included: 0.0						

Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	75	5.0	45.0	125

Subject objectives	To acquaint students with fundamentals of atomic and molecular physics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_W02	The student has a basic knowledge of methods of quantum description of atomic structure and of selected phenomena occurring at the atomic level.	[SW1] Assessment of factual knowledge
K6_W08	The student is introduced to the methodology of experimental work in atomic and particle physics.	[SW1] Assessment of factual knowledge
K6_U04	The student is introduced to the methodology of experimental work in atomic and particle physics.	[SU1] Assessment of task fulfilment

Subject contents	1. Selected quantum mechanical tools of Physics of Atoms and Molecules: a. the virial theorem, b. the Hellmann-Feynman theorem, c. the time-independent perturbation theory, d. the variational method. 2. Isolated one-electron atom in the Schr{\"o}dinger theory: a. separation of the Schr{\"o}dinger-Coulomb equation in spherical coordinates, b. the angular momentum, spherical harmonics, c. process of solving the radial Schr{\"o}dinger-Coulomb equation, d.the Coulomb wave functions in spherical coordinates, e. the Bohr-Schr{\"o}dinger energy levels and their degeneration. 3. Fundamental physical constants of atomic and molecular physics. Systems of units. 4. The Stark effect for the one-electron atom: a. the quadratic effect for the ground state, b. the linear effect (the first excited state as an example). 5. The Zeeman effect for the one-electron atom: a. with electron spin neglected, b. with electron spin taken into account. 6. The ground state of a two-electron atom: a. application of the perturbation theory, b. application of the variational method. 7. Excited states of a two-electron atom. 8. Many-electron atoms. 9. The hydrogen molecular ion. 10. The hydrogen molecule.

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">Knowledge of quantum mechanics at the level of the course "Quantum Mechanics I".</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Exam</td><td>37.5%</td><td>66.67%</td></tr>
<tr><td>Grade for laboratories</td><td>50.0%</td><td>33.33%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">B.H. Bransden, C.J. Joachain, Physics of atoms and molecules, 2nd ed., Prentice Hall, Harlow, 2003</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">1. Z. Leś, Podstawy fizyki atomu, PWN, Warszawa, 2014

2. W. Demtr{\"}oder, Atoms, molecules and photons, 3rd ed., Springer, Berlin, 2018

3. Lecture notes provided by the lecturer (in Polish).</td></tr>
<tr><td>eResources addresses</td><td colspan="2">Podstawowe
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=35927 - Lecturer's notes.
Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3">1. Present types of the Stark effect for the one-electron atom.

2. Describe the ground state of a two-electron atom using the variational method.

3. Describe the ground state of the hydrogen molecule.</td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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